

NSF International

Point-of-Use Drinking Water Treatment System Testing, Certification, Standards and Protocols

**NEHC Meeting
March 23, 2006**

The NSF logo is a blue circle with the letters "NSF" in white. It is located in the bottom right corner of the slide.

NSF

Agenda

1. Overview of NSF
2. American National Standards for POU/POE
3. NSF Protocols for Microbiological Purifiers
4. ETV program and Homeland Security Verifications

NSF Is The Global Leader In Public Health And Safety.

- Founded in 1944.
- Primary business product testing, certification and American National Standards development.
- Serving over 4,000 companies and 8,000 plants across



Our Mission Has Always Focused On Protection Of Public Health And Safety.

NSF International, an independent, not-for-profit non-governmental organization, is dedicated to being the leading global provider of public health and safety-based risk management solutions while serving the interests of all stakeholders.

We make the world safer by improving public health.

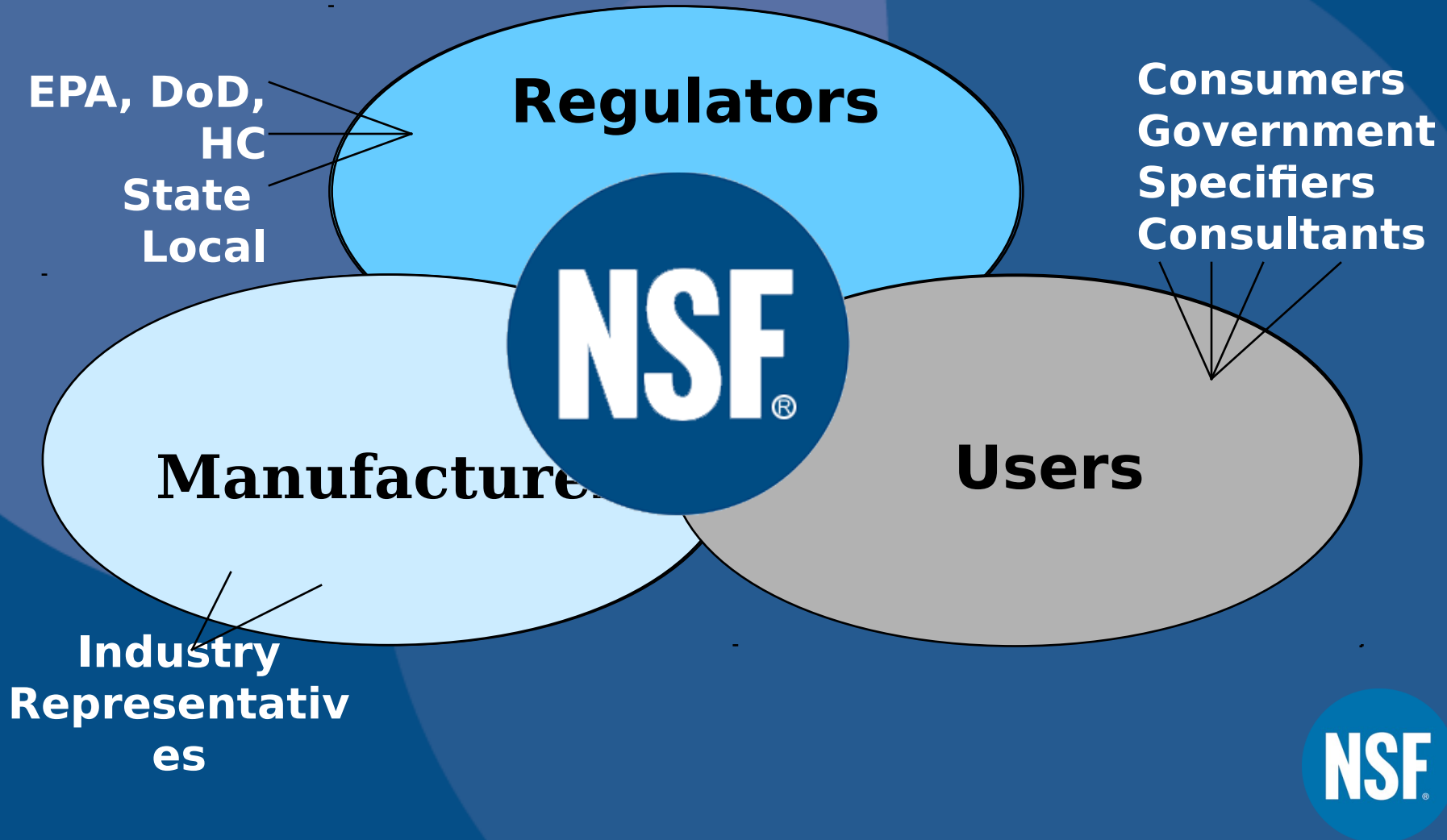


Global Services

NSF Product Certification Water Programs

- Bottled Water Certification
- Plastics Piping
- Plumbing Products
- Drinking Water Treatment Chemicals
- Drinking Water System Components
- Pool and Spa
- Wastewater Treatment Units
- Drinking Water Treatment Units

NSF Consensus Standards



Program History: Drinking Water Treatment Units

- 1968** U.S. Health Officials and Industry Representatives requested NSF develop Standards.
- Demonstrate product performance.
 - Standardize testing and claims.
- 1973** NSF Standard **42** Adopted; Aesthetic Claims.
- 1980** NSF Standard **53** Adopted; Health Claims.
- 1981** NSF Standard **58** Adopted; Reverse Osmosis.
- 1987** NSF Standard **44** Adopted; Softeners.
- 1989** NSF Standard **62** Adopted; Distillation.
- 1991** NSF/ANSI Standard **55** Adopted; Ultraviolet.
- 2003** NSF P231 Microbiological Water Purifiers.
- 2004** NSF ETV Homeland Security Performance Verifications.
- 2005** NSF P248 Handheld Microbiological Water Purifiers.



NSF

Content of NSF Drinking Water Treatment Unit Standards

- Mandatory requirements for all:
 - Material safety.
 - Structural integrity (water tightness).
 - Product literature.
- Options, as selected by Manufacturer:
 - Demonstration of performance for individual contaminant reduction claims.

Contaminant Reduction Testing

- Inorganic
- Organic
- Microbiological
- Particulate
- Radiological

NSF/ANSI Microbiological Standards Today

NSF/ANSI 55 Ultraviolet Disinfection

- Class A
 - Contaminated water (not sewage)
 - Challenged with 1×10^5 /mL MS-2 coliphage
 - Effluent; UV dose equivalent to 40 mJ/cm²
 - Bacteria, viruses, *Cryptosporidium* and *Giardia*
 - 10 day test

NSF/ANSI Microbiological Standards Today

NSF/ANSI 53 Health Effects

- Mechanical filtration and adsorptive media (activated carbon): Cyst reduction
- Potable water only
- Challenge level 5×10^5 /L of live *C. parvum* or 3.00 µm polystyrene microspheres
- Tested with high turbidity and sampled at points of flow reduction (25, 50, 75%)
- Effluent minimum reduction 99.95% (3.3 log)
- *Cryptosporidium*, *Toxoplasma*, *Giardia*, *Entamoeba*

NSF/ANSI Microbiological Standards Today

NSF/ANSI 62 Distillation

- Microbiological Treatment Claims
 - Contaminated water (not sewage)
 - Automatic shut-off
 - Challenged with $1 \times 10^6/\text{mL}$ *B. subtilis* spores
 - Effluent minimum 5 log reduction
 - Bacteria, virus, *Giardia*
 - 7 day test

NSF Protocols

- Managed by NSF's Environmental and Research Services Department.
- Developed generally for small niche markets where an ANS is not needed or justified.
- Developed in a similar way to Standards, but on a smaller scale.
- Published and available the same as a Standard.
- Can evolve into a Standard.
- Can be used as the basis for Certification.
- Twelve available today.

New Developments in Microbiological Water Purifier Testing

- NSF P231 Microbiological Water Purifiers.
- NSF P248 Handheld Microbiological Water Purifiers.
- Aeromedical Water Purifier Testing
- NSF ETV Homeland Security Performance Verifications.

NSF Protocol P231

- Content:
 - Materials.
 - Structural Integrity.
 - Product Literature.
 - Marking.
 - EPA “Guide Standard and Protocol for Testing Microbiological Water Purifiers”.
- Certification same as any DWTU Standard.
- Interim until NSF/ANSI 221 is complete.

NSF Protocol P231

- For waters of unknown quality, but presumed potable.
- Technologies: No limit; specific methods for Ceramic, UV and Halogenated Resins.
- Purifier; All three classes of organisms:
 - **Bacteria; *Klebsiella*, 6 logs**
 - **Virus; Polio and Rota, 4 logs**
 - **Cyst; Crypto, 3 logs**
- Indication of effective lifetime.
- Three units tested.

NSF Protocol P231

- Challenge Waters:
 - Potable water as base.
 - pH 9 (except UV 7.5 and iodinated resins 5)
 - TOC ≥ 10 mg/L
 - Turbidity ≥ 30 NTU (variable; sampling only)
 - Temperature 4°C
 - TDS 1500 mg/L
- General test water (neutral water) first half of the test followed by the challenge water.

NSF Protocol P231

- 60 psig static; no flow control.
- 10/90 cycle; 16 hours/day.
- Halogenated resins to 100% capacity.
- Ceramic and UV for 10½ days.
- Pass/Fail:
 - Compliance with log reduction for 90% of samples; remaining 10% must be within 1 log for bacteria and virus, ½ log for cyst.
 - Geometric mean of all must meet log reduction.

NSF Protocol P248: Emergency Military Operations Microbiological Water Purifiers

P248

- Prepared by U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM) using a grant received from the Army Study Program Management Office.
- CHPPM coordinated closely with personnel from the NSF International, along with a number of other DoD organizations including NEHC who all assisted in developing the protocol.

P248 Scope

- Derived and adapted primarily from the EPA Guide Standard and NSF International P231
- It describes the procedures to be used to test individual water purifiers (IWPs) designed to achieve removal or inactivation of microbiological contaminants, including bacteria, viruses, protozoa, and protozoan cysts and oocysts from virtually any fresh water source likely to be encountered by military personnel during exercises and deployments.

P248 Scope

- Intended only for individual emergency use for short durations as an alternative to the currently fielded iodine tablets and Chlor-Floc[®] disinfection supplies
- Intentionally general in nature so as to be applicable to all IWPs, irrespective of physical construction or technology employed.

Microbiological Reduction Requirements and Surrogates :

Microbial Challenge Organisms:

- Bacteria - 6 log reduction as *Escherichia coli*, *Raoultella terrigena* or *Bacillus subtilis*
- Virus – 4 log reduction as MS2 and fr coliphages
- Cyst – 3 log reduction as *Cryptosporidium parvum* oocysts
- Sampling based on treatment capacity (first draw, 25, 50, 60, 75 and 100%)

P248 Exclusions

- Protocol does not presume to dictate the physical characteristics that make them useful to or desirable by warfighters.
- Those characteristics are defined by units, unit commanders, and missions.
- There are desirable characteristics and operational capabilities that will be considered in the final recommendation as to device suitability for use in various emergency military field operation scenarios.

P248 Scope

- Execution of this protocol for acceptance of an individual water purifier (IWP) will be administered and monitored by a Government Review Agency (GRA) designated by the Department of the Army Office of the Surgeon General (OTSG).
- Just recently adopted; no testing performed to-date.

Aeromedical Water Purifier Testing

Department of the Air Force
Air Force Material Command

Background on Solicitation

- The Air Force Field Water Medic Program conducted a market survey in 2004 that identified commercially available handheld water purification devices with possible applications for military use.
- NSF Protocol P231 (NSF P231): Microbiological Water Purifiers was named in the solicitation as the preferred approach to evaluate the microbiological reduction performance of these devices.

Aeromedical Water Purifier Testing

- Four commercially available devices were chosen by the DoD based on undisclosed criteria.
 - Lever action pump device for mechanical filtration.
 - Personal water bottle using hand-squeeze for mechanical filtration.
 - Batch style bag using gravity flow.
 - UV.

Results

- To date, the results have not been made publicly available.
- The solicitation can be viewed at www.fedbizopps.gov key words:
Aeromedical Water Purifier Testing

Environmental Protection Agency's Environmental Technology Verification Program

- Administered by the USEPA Office of Research and Development
- Purpose: develop test protocols and verify the performance of innovative technologies to improve protection of human health and the environment
- No pass/fail requirements, just report the observed performance
- 2001: 2 centers established at NSF
 - Drinking Water Systems Center
 - Water Quality Protection Center



Homeland Security Verifications

- NSF received funding in 2002 under our ETV Centers to develop test protocols and test products related to water safety:
 - DWS Center: Biological and chemical agent removal by point-of-use (POU) and point-of-entry (POE) drinking water treatment systems
 - WQP Center: building decontamination wastewater treatment systems

POU Homeland Security Verifications

- Purpose: to determine the possible level of protection provided to the user during a contamination event
- Tested commercially available products that represent typical POU RO systems
 - Watts Premier Ultra 5
 - Sears Kenmore Ultrafilter 500
 - Pall/Kinetico Purfecta (*marketed as a microbiological water purifier*)

Microbial Contaminants Verifications Biological Agents Protocol

- Used surrogate organisms, not actual threat agents
 - Bacteria: *B. diminuta* and *H. pseudoflava*
 - Viruses: The coliphages fr, MS2, and PhiX174
 - Chosen based on small size, viruses also chosen based on isoelectric points

Biological Agents Protocol

- Virus challenges conducted at pH 6, 7.5, and 9 to assess any effect of isoelectric point
 - Did not observe any effect
- Tested at both 40 psi and 80 psi inlet pressure
- Total number of challenges
 - Viruses: 6
 - Bacteria: 4

Day	Organism	pH	Pressure
1	<i>H. pseu.</i>	7.5	40
2	<i>H. pseu.</i>	7.5	80
3	<i>B. dim.</i>	7.5	40
4	<i>B. dim.</i>	7.5	80
5	Viruses	6.0	40
6	Viruses	6.0	80
7	Viruses	7.5	40
8	Viruses	7.5	80
9	Viruses	9.0	40
10	Viruses	9.0	80

Biological Agents Protocol

- Tested ten units of each product
 - Five were conditioned for 25 days, five were not conditioned
 - Only conditioned units data is presented here
- Tested only the RO membrane; sediment and/or carbon filters were removed
- Short one day challenges, did not address long-term performance

MS2 and fr Reduction Data

	Influent ($\log_{10}$)		Log Reduction	
	Mean	Range	Mean	Range
Product A	5.9	4.8 – 6.4	4.5	3.2 – 5.9
Product B	5.0	4.5 – 5.7	5.0*	4.2 – 5.7
Product C	4.9	4.4 – 5.6	4.9*	4.3 – 5.6

*All effluents non-detect except for one challenge

- PhiX174 data not included, challenges too low

Bacteria Reduction

	Influent ($\log_{10}$)		Mean Log Reduction
	Mean	Range	
Product A	7.5	6.7 – 8.4	7.5*
Product B	7.6	6.8 – 8.1	7.2 [#]
Product C	6.6	5.9 – 7.1	6.6 [‡]

*All effluents non-detect except for one unit in one challenge

[#]All effluents non-detect except for one unit in two challenges

[‡]All effluents non-detect

Conclusions

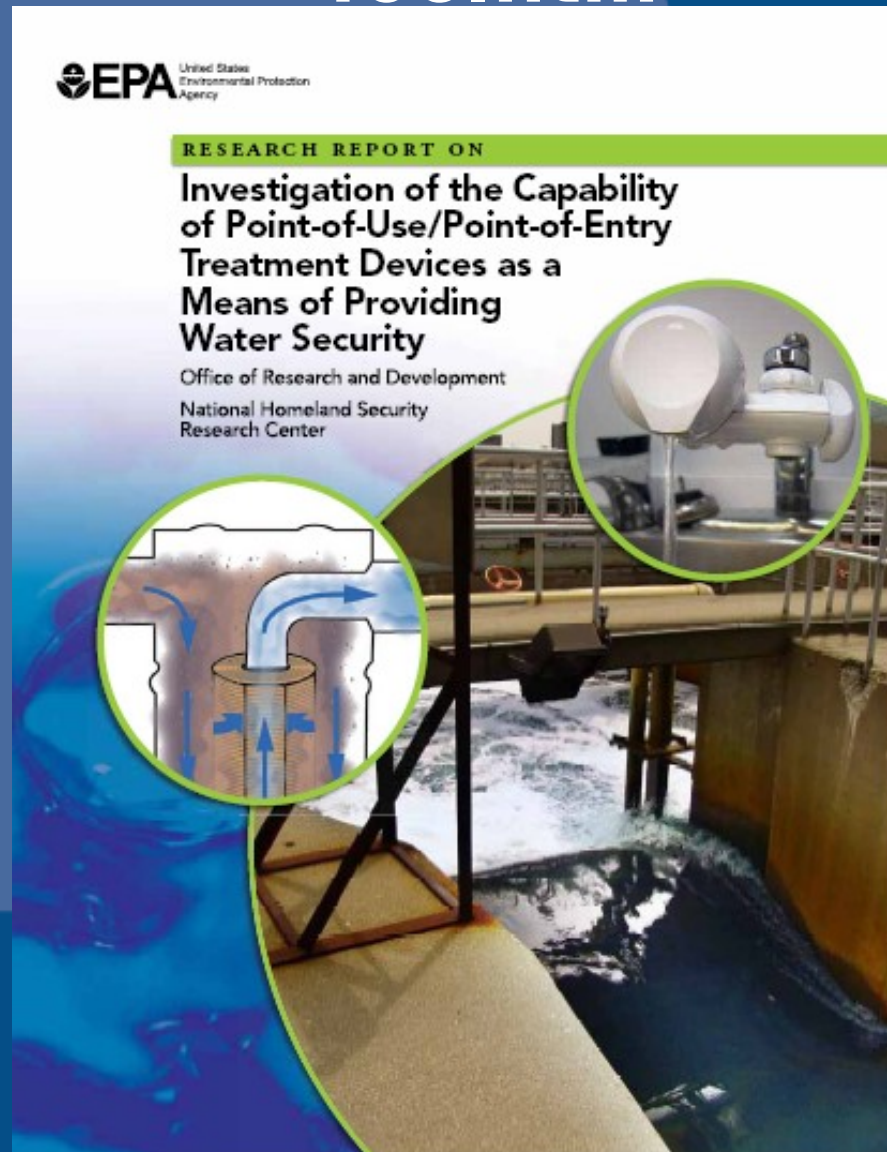
- POU systems with an RO membrane and a high-quality post-membrane carbon filter can offer significant protection against both biological and chemical agents
- No membrane or seal degradation due to chemical exposure was detected

ETV Reports

www.nsf.org/etv

www.epa.gov/etv

<http://www.epa.gov/nhsrc/news/news022406.htm>



NSF

Contact Information

Bruce Bartley
ETV Program Manager at NSF
734-769-5148
bartley@nsf.org

Nikki Beetsch
ERS Business Unit Manager
734-913-5718
Beetsch@nsf.org

Tom Bruursema
General Manager, Drinking Water Systems
734-769-5575
bruursema@nsf.org